e. ♀ ad. sk. Coonoor, Nilghiris, Jan. 28, 1881 (*W. Davison*). Hume Collection.

Wing 13·9 inches. Very pale below, with whitish cross-bars, somewhat coalescing on the chest, which is consequently more uniform. Face deep ochre, barred across with blackish.

f. Ad. sk. Southern India (*Dr. Jerdon*). J. Gould, Esq.

Wing 13·6 inches. Very tawny in appearance, the face being deep ochreous buff, rufous near the eye, with scarcely any sign of white on the frill of the ear-coverts.

g. Ad. sk. Nuwara Eliya, Ceylon. Mr. E. Boate [C.].

Wing 13·2 inches. A dark bird, with the chest barred like the rest of the under surface; face deep ochreous buff, with evident traces of dusky cross bars.

h. Ad. sk. Nuwara Eliya, Ceylon. Mr. E. Boate [C.].

Wing 12·5 inches. A darker bird, with the chest coarsely barred with dark brown, somewhat uniform on the sides. Face uniform deep rufous ochre, with a slight indication of white on the lower part near the frill.

i. Ad. sk. Kandy (*A. White*). Hume Collection.

Wing 11·9 inches. Strongly tinged with ochreous below. Face bright orange-rufous, with scarcely any white on the lower margin. No sign of cross-barring on the face.

2. On the Presence of a Canal-System, evidently Sensory, in the Shields of Pteraspidian Fishes. By A. Smith Woodward, F.Z.S., F.G.S., of the British Museum (Natural History).

[Received April 28, 1887.]

In his well-known monograph on the Cephalaspidæ, Professor Ray Lankester described and figured[1] a number of small depressions or "pits," arranged in double series upon the external surface of certain head-shields pertaining to the Heterostracous or Pteraspidian division of the group; and three years subsequently, in making known a new generic type, *Holaspis*[2], he remarked still further upon the same curious pittings, which were shown in this fossil with unusual distinctness. These he naturally regarded as "the sites of soft tegumentary structures, in all probability of those characteristic sensory-follicles of fishes," with which they agreed in disposition; and then followed another inference, "that a secreting membrane was closely attached to the striated calcareous material" of the outer layer of the shield in the original living fish.

Some of these fossils are now in the British Museum, the fine

[1] E. Ray Lankester, "The Cephalaspidæ" (Mon. Palæont. Soc., 1868, 1870), pp. 17, 22, pl. i. figs. 1, 4, 8; pl. vi. figs. 1, 6; pl. vii. figs. 8, 9.

[2] E. Ray Lankester, "On *Holaspis scriceus*," Geol. Mag. vol. x. (1873), pp. 241–245, pl. x.

shield of *Holaspis* having been presented by its discoverer Dr. D. M. MacCullough, and the originals of Lankester's pl. i. fig. 8, pl. vi. fig. 6, having been acquired by purchase and bequest; and there are several other important specimens, likewise displaying in a greater or less degree the same peculiar superficial marks. With one exception, however, they afford no more precise information as to the character of the sensory lines thus indicated; and the extreme rarity of the combination of circumstances by which a single example is made to throw further light upon the subject renders this fossil of unusual interest and value. I have lately met with it among a number of more or less broken shields obtained from the collection of the late Mr. E. Baugh, and the biological significance of the features it presents seems to render it worthy of some brief notice.

The specimen in question is a fragmentary median plate, referable

Fragmentary Median Plate of Shield of *Pteraspis crouchii*, Lower Old Red Sandstone, Herefordshire. [Brit. Mus. no. 42163 *a*.]

to the cephalic buckler of *Pteraspis crouchii*, and is in the ordinary mineral condition of the Pteraspidian fossils from the Lower Old Red Sandstone of Herefordshire, whence it was derived. The striated outer layer is mostly removed, only occurring in small isolated patches, and the median "cancellated" layer[1] is thus very completely exposed to view. But, unlike all other similarly abraded examples in the collection, this fossil shows not merely the innumerable small polygonal cavities, with their partitions, constituting the middle portion of the shield, but also a branching system of wide canals, which have no connection with these chambers, though distinctly ramifying through them. The latter have been most beautifully rendered evident by a dark infiltration of the oxides of iron and manganese (a kind of natural "injection"), and they are seen to have opened upon the external surface in a double series of orifices of considerable size. The "pits" or "depressions" described by Lankester, in fact, are proved to be really the openings

[1] T. H. Huxley, "On *Cephalaspis* and *Pteraspis*," Quart. Journ. Geol. Soc. vol. xiv. (1858) pp. 267–280.

of an extensive canal-system, which indicates a more highly specialized development of the "lateral-line" structures than has hitherto been suspected.

As shown by the drawing (p. 479), there are four longitudinal canals, two marginal, and two situated close together in the median area of the plate; and the latter pair diverge in front, perhaps meeting the former at the edge, while more posteriorly they are all connected at irregular intervals by similar transversely-directed passages. The median commissural branches extend directly across the space between the two longitudinal canals they unite; but those proceeding to the lateral canals take a slightly more devious course, being inclined either backwards or forwards. Throughout their extent the tubular excavations give rise to short diverticula, alternately left and right, which place them in connection with the external pores; and these are most numerous in the median portion of the shield and the great marginal trunks, being relatively further apart in the lateral commissures.

The complexity and widely-spread character of the system is still more satisfactorily demonstrated in the almost perfect specimen of *Holaspis* already referred to; and here, it will be observed, there is an essentially similar arrangement. Our fossil corresponds to the central portion of this shield, which appears to consist of the homologues of the seven plates of *Pteraspis* wholly fused together. And it is perhaps worthy of note that neither here nor in any other Pteraspidian have distinct traces of the pores been detected upon the rostral region in advance of the "orbital" notches or apertures.

Finally, it is interesting to institute a comparison between these ancient traces of a "lateral-line" system and the various structures adapted for the protection of the corresponding sense-organs in existing fishes. Chimæroids possess merely the primitive open groove; but in Selachians the canal is complete, and there are also present the short secondary diverticula leading to the external pores. The last-named branches, however, are all directed to one side (outwards or downwards) of the main canal in the Rays and upon the trunk of the Sharks; and there is no very close agreement with *Pteraspis* even in the cephalic region of the latter group, where the branches are given off in both directions, but are not completely closed, being perforated by a series of small orifices in addition to the terminal one[1]. Moreover, it is scarcely likely that these canals in the old Devonian fish had the Selachian mode of development. In bony fishes, where the structures bear a similar relation to the hard skeletal parts, in most cases excavating them, there is naturally a much greater resemblance; and some of the most specialized Teleostei (*e. g.* the Pleuronectidæ) exhibit an almost precisely corresponding "feather-barb" arrangement[2]. Unfortunately, however, the character of the sense-organs themselves necessarily remains unknown, for the palæontologist can rarely give much sure

[1] P. C. Sappey, 'Etudes sur l'Appareil Mucipare et sur le Système Lymphatique des Poissons,' 1880, p. 55, pl. ii. fig. 2, pl. x. fig. 1.

[2] P. C. Sappey, *op. cit.* p. 44, pl. xi. figs. 3, 4.

information as to the perishable tissues originally associated with the skeletal fragments he finds in the rocks; and such is all the more to be regretted in the present instance, since the Pteraspidian fishes are the earliest undoubted members of the class that have hitherto been recognized in geological history.

3. Note on the "Lateral Line" of *Squaloraja*.

By A. Smith Woodward, F.Z.S.

[Received April 28, 1887.]

In my description of the fossil Liassic Selachian *Squaloraja*, read before this Society in October last (see P. Z. S, 1886, p. 527), some series of very minute dermal ringlets are noted in the cephalic and caudal regions, and these are regarded as designed for the strengthening of the edges of those flattened parts of the body. They are marked by the letter *d* adjoining the rostral cartilages in fig. 1, pl. lv. *loc. cit.*, and are also shown in connected series along the tail, parallel to an irregular dermal ridge which is similarly designated. They are, moreover, seen in the original of fig. 3, and in the caudal region of the specimen previously figured by Davies.

Subsequent studies have led me to determine that these curious structures are truly the supports of the canal of the "lateral line." In the living *Chimæra*, the open groove in which the sense-organs are lodged is strengthened throughout by precisely similar rings, as originally observed by Stannius[1] and Leydig[2], and figured and described by the latter; and von Meyer[3] has likewise discovered these calcifications in a closely-allied fossil form from the Upper Jurassic of Bavaria. They have been aptly compared with the tracheal rings of some small air-breathing vertebrate. Their remains upon the tail show that they were incomplete, exactly as in the existing genus just mentioned; and we may therefore conclude that *Squaloraja* was characterized by an open sensory canal of the essential Chimæroid type. The circumstance adds one more to the series of points in which the old Selachian seems to be related to the last-named order, and it is thus particularly worthy of note.

[1] H. Stannius, Lehrb. vergl. Anat Wirbelthiere, 1846, p. 49.

[2] F. Leydig, "Zur Anatomie und Histologie der *Chimæra monstrosa*," Müller's Archiv, 1851, p. 251, pl. x. fig. 2.

[3] H. von Meyer, "*Chimæra* (*Ganodus*) *avita*, aus dem lithographischen Schiefer von Eichstätt," Palæontographica, vol. x. (1862), p. 92, pl. xii.